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10/616,044	07/08/2003	Michael X. Yang	AMAT/7669.P2/CMP/ECP/RKK	9799

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MÖSER, PATTERSON & SHERIDAN, LLP
APPLIED MATERIALS, INC.
3040 POST OAK BOULEVARD, SUITE 1500
HOUSTON, TX 77056

EXAMINER

VAN, LUAN V

ART UNIT PAPER NUMBER

1753

DATE MAILED: 07/20/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

10/616,044

Applicant(s)

YANG ET AL.

Examiner

Luan V. Van

Art Unit

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --
Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 21 November 2003.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-28 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1-28 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☒ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
- ☐ Certified copies of the priority documents have been received.
 - ☐ Certified copies of the priority documents have been received in Application No. _____.
 - ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☒ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)
Paper No(s)/Mail Date 11/20/03.
- 4) ☐ Interview Summary (PTO-413)
Paper No(s)/Mail Date. _____
- 5) ☐ Notice of Informal Patent Application (PTO-152)
- 6) ☐ Other: _____

DETAILED ACTION

Drawings

The drawings are objected to as failing to comply with 37 CFR 1.84(p)(5) because they do not include the following reference sign(s) mentioned in the description: Landau et al. '7712 is missing in the figures. Corrected drawing sheets in compliance with 37 CFR 1.121(d) are required in reply to the Office action to avoid abandonment of the application. Any amended replacement drawing sheet should include all of the figures appearing on the immediate prior version of the sheet, even if only one figure is being amended. Each drawing sheet submitted after the filing date of an application must be labeled in the top margin as either "Replacement Sheet" or "New Sheet" pursuant to 37 CFR 1.121(d). If the changes are not accepted by the examiner, the applicant will be notified and informed of any required corrective action in the next Office action. The objection to the drawings will not be held in abeyance.

Claim Objections

Claims 3, 7, 9 and 24 are objected to because of the following informalities:

The claims include improper alternative language or an improper Markush group expression (MPEP 2173.05(h)). The present form, which is not supported by the disclosure, appears to mean that all members within the group are present

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simultaneously instead of one member is selected from a group. The claims are prosecuted based on the assumption that one member is selected from a group.

Appropriate correction is required.

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

The factual inquiries set forth in *Graham v. John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under 35 U.S.C. 103(a) are summarized as follows:

1. Determining the scope and contents of the prior art.
2. Ascertaining the differences between the prior art and the claims at issue.
3. Resolving the level of ordinary skill in the pertinent art.
4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

Claims 1-3, 9-10, 13-16, 25-26 and 28 are rejected under 35 U.S.C. 103(a) as being unpatentable over Reid et al. in view of Dordi et al or Woodruff et al.

Regarding claims 1 and 25-26, Reid et al. teach a method for plating copper onto a substrate, comprising: positioning the substrate in a solution (paragraph 21), the

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solution comprising: an acid source at a concentration of between about 0-300 g/L (Table 1); a copper source at a concentration of between about 10-60 g/L (or about 0.16-0.94 M); and chlorine ions at a concentration of between about 20-200 mg/L (or about 20-200 ppm); and applying a plating bias between the substrate and an anode (paragraphs 24-25). The ranges of concentration as taught by Reid et al. are within the ranges of the instant claims.

The difference between the reference to Reid et al. and the instant claims is that the reference does not explicitly teach using an ionic membrane. The anolyte chamber and the catholyte chamber are inherently created when a membrane is used.

Dordi et al. disclose an electroplating apparatus with an ionic membrane (paragraph 108 and 140) to filter out anode sludge from the electrolyte solution and to allow metal ions that are contained within the electrolytic solution in the anode chamber to pass through the membrane to within the main body of the electroplating cell (paragraph 140).

Woodruff et al. disclose an electroplating apparatus with a NAFION perfluorinated membrane that is permeable to cations, but reject anions and non-polar species in order to eliminate the consumption of additives at the anodes (paragraphs 87-88)

It would have been obvious to one having ordinary skill in the art at the time the invention was made to modify the electroplating method of Reid et al. by using the ionic membrane of either Dordi et al. or Woodruff et al., because the ionic membrane would filter out anode sludge from the electrolyte solution and eliminate the consumption of additives at the anodes. Although Reid et al. does not explicitly teach whether the copper source concentration is in the anolyte or the catholyte chamber, it is within the ability of one having ordinary skill in the art to have the concentration in either chamber because the solution in both chambers are used for electroplating copper.

Regarding claim 2, Reid et al. teach an electroplating method wherein the solution further comprises: a leveler at a concentration of between about 0.5-8 ml/L (Table 1); a suppressor at a concentration of between about 1-6 ml/L; and an accelerator at a concentration of between about 0.5-8 ml/L. The ranges of concentration as taught by Reid et al. are within the ranges of the instant claims.

Regarding claim 3, Reid et al. teach an electroplating method wherein the suppressor comprises polyethylene oxide and their derivatives (paragraph 19), which would also include propylene oxide.

Regarding claim 9, Reid et al. does not explicitly teach an electroplating method wherein the anode comprises a copper anode.

Dordi et al. disclose an electroplating apparatus wherein the anode comprises a copper anode (paragraph 108).

It would have been obvious to one having ordinary skill in the art at the time the invention was made to modify the electroplating method of Reid et al. by using the copper anode of Dordi et al., because using a copper anode for electroplating copper is conventionally known.

Regarding claim 10, Reid et al. teach an electroplating method for plating copper into features formed on a semiconductor substrate (paragraph 7), comprising: positioning the substrate in a plating cell (paragraph 21), and applying a plating bias between the anode and the substrate (paragraph 21-25). Reid et al. also teaches the copper plating solution comprises a copper source at a concentration of between about 10-60 g/L (Table 1).

The difference between the reference to Reid et al. and the instant claims is that the reference does not explicitly teach using an ionic membrane, thereby forming an anolyte and catholyte chamber.

Dordi et al. disclose an electroplating apparatus with an ionic membrane (paragraph 108 and 140) to filter out anode sludge from the electrolyte solution and to allow metal ions that are contained within the electrolytic solution in the anode chamber

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to pass through the membrane to within the main body of the electroplating cell (paragraph 140). The ionic membrane is positioned to separate the anolyte volume from the catholyte volume (figures 27-28). Dordi et al. also discloses replenishing the copper ions plated onto the substrate from the catholyte solution with copper ions transported from the anolyte solution via the ionic membrane (paragraph 111; figures 21-23, flow B).

Woodruff et al. disclose an electroplating apparatus with a NAFION perfluorinated membrane that is permeable to cations, but reject anions and non-polar species in order to eliminate the consumption of additives at the anodes (paragraphs 87-88)

It would have been obvious to one having ordinary skill in the art at the time the invention was made to modify the electroplating method of Reid et al. by using the ionic membrane of either Dordi et al. or Woodruff et al., because the ionic membrane would filter out anode sludge from the electrolyte solution and eliminate the consumption of additives at the anodes. Although Reid et al. does not explicitly teach whether the copper source concentration is in the anolyte or the catholyte chamber, it is within the ability of one having ordinary skill in the art to have the concentration in either chamber because the solution in both chambers are used for electroplating copper.

Regarding claims 13-14, Reid et al. does not explicitly teach an electroplating method wherein a diffusion member is positioned between an upper surface of the ionic membrane and the substrate nor that the diffusion member comprises a porous ceramic disk.

Dordi et al. disclose an electroplating apparatus with a porous ceramic diffusion member positioned between an upper surface of the ionic membrane and the substrate (paragraphs 132-133). The diffusion member enhances the uniformity of the fluid flow of electrolyte solution as the electrolyte solution contacts the substrate within the electrolyte solution contained in the electrolytic cell (paragraph 133).

It would have been obvious to one having ordinary skill in the art at the time the invention was made to modify the electroplating method of Reid et al. by using the porous ceramic diffusion member of Dordi et al., because the diffusion member enhances the uniformity of the fluid flow of electrolyte solution as the electrolyte solution contacts the substrate within the electrolyte solution contained in the electrolytic cell.

Regarding claims 15-16 and 28, Reid et al. does not explicitly teach an electroplating method wherein the ionic membrane comprises a membrane having a fluorized polymer matrix nor a membrane having a polydivinylbenzol matrix.

Dordi et al. disclose an electroplating apparatus wherein the ionic membrane comprises a polyvinylidene fluoride membrane as an example (paragraph 140), which is a fluorized polymer matrix. A membrane having a polydivinylbenzol matrix is structurally similar to that of a polyvinylidene fluoride membrane and it would function in an equivalent manner.

Woodruff et al. disclose an electroplating apparatus with a NAFION perfluorinated membrane that is permeable to cations, but reject anions and non-polar species in order to eliminate the consumption of additives at the anodes (paragraphs 87-88)

It would have been obvious to one having ordinary skill in the art at the time the invention was made to modify the electroplating method of Reid et al. by using the fluoride membrane of either Dordi et al. or Woodruff et al., because the ionic membrane would filter out anode sludge from the electrolyte solution and eliminate the consumption of additives at the anodes. Although Reid et al. does not explicitly teach whether the copper source concentration is in the anolyte or the catholyte chamber, it is within the ability of one having ordinary skill in the art to have the concentration in either chamber because the solution in both chambers are used for electroplating copper. Further, it is within the ability of one having ordinary skill in the art to use a membrane having a polydivinylbenzol matrix, because it is structurally similar to that of a polyvinylidene fluoride membrane and it would function in an equivalent manner.

Claims 4 and 11 are rejected under 35 U.S.C. 103(a) as being unpatentable over Reid et al. in view of Dordi et al. or Woodruff et al., and further in view of Dahms et al.

Reid et al. and Dordi et al. teach the electroplating method as described above in addressing claims 1 and 10.

Regarding claim 4, Reid et al. and Dordi et al. do not explicitly teach an electroplating method wherein the accelerator comprises sulfo propyldisulfide.

Dahms et al. teach an electroplating method for copper having an accelerator comprising of bis-(w-sulfopropyl)-disulfide, disodium salt (Table 2).

It would have been obvious to one having ordinary skill in the art at the time the invention was made to modify the combined method of Reid et al. and Dordi et al. or Woodruff et al. by using the accelerator of Dahms et al., because a sulfo propyldisulfide accelerator is a suitable additive for electroplating copper.

Regarding claim 11, the references do not explicitly teach an electroplating method wherein the copper concentration is supplied by copper sulfate pentahydrate having a molarity of between about 0.8M and about 0.9M.

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Dahms et al. teach an electroplating method for copper using copper sulfate pentahydrate having a concentration of 20-250 g/L (or about 0.08-1.0 M; column 8 lines 5-15), which is within the reach of the instant claim.

It would have been obvious to one having ordinary skill in the art at the time the invention was made to modify the combined method of Reid et al. and Dordi et al. or Woodruff et al. by using the copper sulfate pentahydrate of Dahms et al., because copper sulfate pentahydrate is suitable and is conventionally known for electroplating copper.

Claims 5-8, 12, 17-18 and 27 are rejected under 35 U.S.C. 103(a) as being unpatentable over Reid et al. in view of Dordi et al. or Woodruff et al., and further in view of Horkans et al.

Reid et al., Dordi et al. and Woodruff et al. teach the electroplating method as described above in addressing claims 1, 10 and 25.

Regarding claims 5, 12 and 27, the references do not explicitly teach an electroplating method wherein the anolyte has a pH of between about 2 and about 4.8.

Horkans et al. teach that an electroplating bath for plating copper typically has an acidic pH of up to about 5 (paragraph 24), which is within the reach of the instant claim.

It would have been obvious to one having ordinary skill in the art at the time the invention was made to modify the combined method of Reid et al. and Dordi et al. or Woodruff et al. by using the pH of Horkans et al., because an electroplating bath for plating copper having an acidic pH of up to about 5 is typically used and conventionally known.

Regarding claim 6, Reid et al. teach an electroplating method for plating copper wherein the solution comprises copper ions of between 10-60 g/L (or about 0.16-0.94 M) (Table 1), which is within the reach of the instant claim.

Regarding claim 7, Reid et al. teach an electroplating method for plating copper wherein the solution comprises copper sulfate (paragraph 17).

Regarding claim 8, Reid et al. does not explicitly teach an electroplating method wherein the solution provides a copper transport of copper ions through the ionic membrane of between about 90% and about 100%,

Although Dordi et al. or Woodruff et al. do not explicitly disclose the percentage of copper ion transport through the membrane, the ionic membrane of either Dordi et al. or Woodruff et al. would transport copper ions through the ionic membrane of between about 90% and about 100%, because it is made of a porous material and the pore width

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of the membrane can be selected to allow copper ion transport of between about 90% and about 100%. The membrane of Woodruff et al. is made of the same material as that of the instant claim.

It would have been obvious to one having ordinary skill in the art at the time the invention was made to modify the method of Reid et al. and Horkans et al. by using the ionic membrane of Dordi et al. or Woodruff et al., because the ionic membrane of Dordi et al. and Woodruff et al. would transport copper ions through the ionic membrane of between about 90% and about 100%, since it is made of a porous material and the pore width of the membrane can be selected to allow copper ion transport of between about 90% and about 100%, and since it is made of the same material as that of the instant claim.

Regarding claim 17, Reid et al. teach a method for plating copper onto a substrate, wherein the solution comprises: an acid source at a concentration of between about 0-300 g/L (Table 1); a copper source at a concentration of between about 10-60 g/L (or about 0.16-0.94 M); and chlorine ions at a concentration of between about 20-200 mg/L (or about 20-200 ppm); and applying a plating bias between the substrate and an anode (paragraphs 24-25). The ranges of concentration as taught by Reid et al. are within the ranges of the instant claim.

Regarding claim 18, Reid et al. teach an electroplating method wherein the solution further comprises: a leveler at a concentration of between about 0.5-8 ml/L (Table 1); a suppressor at a concentration of between about 1-6 ml/L; and an accelerator at a concentration of between about 0.5-8 ml/L. The ranges of concentration as taught by Reid et al. are within the ranges of the instant claim.

Claims 19-24 are rejected under 35 U.S.C. 103(a) as being unpatentable over Reid et al. in view of Dordi et al. or Woodruff et al. and Horkans et al.

Regarding claim 19, Reid et al. teach an electroplating method for plating copper into features formed on a semiconductor substrate (paragraph 7), comprising: positioning the substrate in a plating cell (paragraph 21), and applying a plating bias between the anode and the substrate (paragraph 21-25). Reid et al. also teaches the copper plating solution comprises a copper source at a concentration of between about 10-60 g/L (or about 0.16-0.94 M; see Table 1), which is within the range of the instant claim.

The difference between the reference to Reid et al. and the instant claims is that the reference does not explicitly teach using an ionic membrane, thereby forming an anolyte and catholyte chamber, nor using a solution having a pH of between about 2 and about 4.8.

Dordi et al. disclose an electroplating apparatus with an ionic membrane (paragraph 108 and 140) to filter out anode sludge from the electrolyte solution and to allow metal ions that are contained within the electrolytic solution in the anode chamber to pass through the membrane to within the main body of the electroplating cell (paragraph 140). The ionic membrane is positioned to separate the anolyte volume from the catholyte volume (figures 27-28). Dordi et al. also discloses replenishing the copper ions plated onto the substrate from the catholyte solution with copper ions transported from the anolyte solution via the ionic membrane (paragraph 111; figures 21-23, flow B).

Woodruff et al. disclose an electroplating apparatus with a NAFION perfluorinated membrane that is permeable to cations, but reject anions and non-polar species in order to eliminate the consumption of additives at the anodes (paragraphs 87-88)

Horkans et al. teach that an electroplating bath for plating copper typically has an acidic pH of up to about 5 (paragraph 24), which is within the reach of the instant claim.

It would have been obvious to one having ordinary skill in the art at the time the invention was made to modify the electroplating method of Reid et al. by using the ionic membrane of either Dordi et al. or Woodruff et al., because the ionic membrane would filter out anode sludge from the electrolyte solution and eliminate the consumption of

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additives at the anodes. Although Reid et al. does not explicitly teach whether the copper source concentration is in the anolyte or the catholyte chamber, it is within the ability of one having ordinary skill in the art to have the concentration in either chamber because the solution in both chambers are used for electroplating copper. Although Reid et al. does not explicitly teach whether the copper source concentration is in the anolyte or the catholyte chamber, it is within the ability of one having ordinary skill in the art to have the concentration in either chamber because the solution in both chambers are used for electroplating copper. Further, it would have been obvious to one having ordinary skill in the art to modify the method of Reid et al. with the ionic membrane of either Dordi et al. or Woodruff et al. by using the pH of Horkans et al., because an electroplating bath for plating copper having an acidic pH of up to about 5 is typically used and conventionally known.

Regarding claim 21, Reid et al. does not explicitly teach an electroplating method wherein the solution provides a copper transport of copper ions through the ionic membrane of between about 90% and about 100%,

Dordi et al. disclose an electroplating apparatus with an ionic membrane (paragraph 108 and 140) to filter out anode sludge from the electrolyte solution and to allow metal ions that are contained within the electrolytic solution in the anode chamber to pass through the membrane to within the main body of the electroplating cell (paragraph 140).

Woodruff et al. disclose an electroplating apparatus with a NAFION perfluorinated membrane that is permeable to cations, but reject anions and non-polar species in order to eliminate the consumption of additives at the anodes (paragraphs 87-88)

Although Dordi et al. or Woodruff et al. do not explicitly disclose the percentage of copper ion transport through the membrane, the ionic membrane of either Dordi et al. or Woodruff et al. would transport copper ions through the ionic membrane of between about 90% and about 100%, because it is made of a porous material and the pore width of the membrane can be selected to allow copper ion transport of between about 90% and about 100%. The membrane of Woodruff et al. is made of the same material as that of the instant claim.

It would have been obvious to one having ordinary skill in the art at the time the invention was made to modify the method of Reid et al. and Horkans et al. by using the ionic membrane of Dordi et al. or Woodruff et al., because the ionic membrane of Dordi et al. and Woodruff et al. would transport copper ions through the ionic membrane of between about 90% and about 100%, since it is made of a porous material and the pore width of the membrane can be selected to allow copper ion transport of between about 90% and about 100%, and because it is made of the same material as that of the instant claim.

Regarding claim 22, Reid et al. teach a method for plating copper onto a substrate, wherein the solution comprises: an acid source at a concentration of between about 0-300 g/L (Table 1); a copper source at a concentration of between about 10-60 g/L (or about 0.16-0.94 M); and chlorine ions at a concentration of between about 20-200 mg/L (or about 20-200 ppm); and applying a plating bias between the substrate and an anode (paragraphs 24-25). The ranges of concentration as taught by Reid et al. are within the ranges of the instant claim.

Regarding claim 23, Reid et al. teach an electroplating method wherein the solution further comprises: a leveler at a concentration of between about 0.5-8 ml/L (Table 1); a suppressor at a concentration of between about 1-6 ml/L; and an accelerator at a concentration of between about 0.5-8 ml/L. The ranges of concentration as taught by Reid et al. are within the ranges of the instant claim.

Regarding claim 24, Reid et al. does not explicitly teach an electroplating method wherein the anode comprises a copper anode.

Dordi et al. disclose an electroplating apparatus wherein the anode comprises a copper anode (paragraph 108).

It would have been obvious to one having ordinary skill in the art at the time the invention was made to modify the combined method of Reid et al. and Horkans et al. by using the copper anode of Dordi et al., because using a copper anode for electroplating copper is conventionally known.

Claims 1 and 25-26 are rejected under 35 U.S.C. 103(a) as being unpatentable over Landau et al. '522 in view of Dordi et al or Woodruff et al.

Landau et al. '522 teach a method for plating copper onto a substrate, comprising the solution having an acid source at a concentration of up to 0.4 M (or up to the 40 g/L; column 5 lines 2-4); a copper source at a concentration of about 0.85 M (column 5 lines 11-14); and chlorine ions at a concentration of between about 10-100 ppm (column 5 lines 31-34). These ranges of concentration as taught by Landau et al. '522 are within the ranges of the instant claims. With respect to positioning the substrate in a solution and applying a plating bias between the substrate and an anode, these steps are inherently performed in an electroplating process.

The difference between the reference to Landau et al. '522 and the instant claims is that the reference does not explicitly teach using an ionic membrane. The anolyte chamber and the catholyte chamber are inherently created when a membrane is used.

Dordi et al. disclose an electroplating apparatus with an ionic membrane (paragraph 108 and 140) to filter out anode sludge from the electrolyte solution and to allow metal ions that are contained within the electrolytic solution in the anode chamber to pass through the membrane to within the main body of the electroplating cell (paragraph 140).

Woodruff et al. disclose an electroplating apparatus with a NAFION perfluorinated membrane that is permeable to cations, but reject anions and non-polar species in order to eliminate the consumption of additives at the anodes (paragraphs 87-88)

It would have been obvious to one having ordinary skill in the art at the time the invention was made to modify the electroplating method of Landau et al. '522 by using the ionic membrane of either Dordi et al. or Woodruff et al., because the ionic membrane would filter out anode sludge from the electrolyte solution and eliminate the consumption of additives at the anodes. Although Landau et al. '522 does not explicitly teach whether the copper source concentration is in the anolyte or the catholyte chamber, it is within the ability of one having ordinary skill in the art to have the concentration in either chamber because the solution in both chambers are used for electroplating copper.

Claims 10 and 13-14 are rejected under 35 U.S.C. 103(a) as being unpatentable over Landau '433 in view of Dordi et al or Woodruff et al.

Regarding claim 10, Landau '433 teach an electroplating method for plating copper into features formed on a semiconductor substrate (column 2 lines 4-6), comprising: positioning the substrate in a plating cell (figure 2), wherein the plating cell comprises: a catholyte volume containing a catholyte solution (solution above the anode in figure 2), an anolyte volume containing an anolyte solution (solution within the porous anode enclosure in figure 2), a porous membrane positioned to separate the anolyte volume from the catholyte volume (column 12 lines 38-54), and an anode positioned in the anolyte volume, applying a plating bias between the anode and the substrate (column 16 lines 7-45), plating copper ions onto the substrate from the catholyte solution (column 15 lines 64 -- column 16 lines 6), and replenishing the copper ions (from the soluble copper anode) plated onto the substrate from the catholyte solution with copper ions transported from the anolyte solution via the membrane (column 12 lines 49-60), wherein the anolyte solution has a copper concentration of greater than 0.5 M (or greater than about 31 g/L; column 17 lines 41-56).

The difference between the reference to Landau '433 and the instant claim is that the reference does not explicitly teach that porous membrane is an ionic membrane.

Dordi et al. disclose an electroplating apparatus with an ionic membrane (paragraph 108 and 140) to filter out anode sludge from the electrolyte solution and to allow metal ions that are contained within the electrolytic solution in the anode chamber to pass through the membrane to within the main body of the electroplating cell (paragraph 140).

Woodruff et al. disclose an electroplating apparatus with a NAFION perfluorinated membrane that is permeable to cations, but reject anions and non-polar species in order to eliminate the consumption of additives at the anodes (paragraphs 87-88)

It would have been obvious to one having ordinary skill in the art at the time the invention was made to modify the electroplating method and apparatus of Landau '433 by using the ionic membrane of either Dordi et al. or Woodruff et al., because the ionic membrane would filter out anode sludge from the electrolyte solution and eliminate the consumption of additives at the anodes.

Regarding claims 13-14, Landau '433 teach an electroplating method wherein a porous ceramic flow adjuster or diffusion member (column 13 lines 33-40) is positioned between an upper surface of the ionic membrane and the substrate (figure 5).

Conclusion

The prior art made of record and not relied upon is considered pertinent to the applicant's disclosure. Mayer et al. also teach using a polymeric ionic membrane in a copper electroplating cell (column 16 lines 50-66). Landau et al. '771 teach a similar copper plating solution.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Luan V. Van whose telephone number is 571-272-8521. The examiner can normally be reached on M-F 8:30-5:00.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Nam Nguyen can be reached on 571-272-1342. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

LVV
7/13/05



NAM NGUYEN
SUPERVISORY PATENT EXAMINER
TECHNOLOGY CENTER 1700